AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF OWEN COUNTY, INDIANA

AUGUST, 1966

NO. 11

Joint Highway Research Project

by

P.T. YEH

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Final Report

AIRPHOTO INTERPRETATION OF ENGINEERING SOILS
OF
OWEN COUNTY, INDIANA

To: Dr. G. A. Leonards, Director
Joint Highway Research Project

August 10, 1966

From: H. L. Michael, Associate Director
Joint Highway Research Project

File: 1-5-38-29
Project: C-36-51 B

The attached report entitled "Airphoto Interpretation of Engineering Soils of Owen County, Indiana," completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 39th report in the series. The report was prepared by P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Owen County was done primarily by airphoto interpretation. Several soil profiles were sampled by the Soil Conservation Service and soil tests were performed by the Soil Testing Laboratory of the Joint Highway Research Project. Engineering test data on various soil horizons are included in the report and generalized soil profiles of the major soil groups are presented on the Soil Map. An ozalid print of the engineering soils map is included in the report.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
Associate Director

HLM:jgs

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Final Report

AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF OWEN COUNTY, INDIANA

by
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Research Engineer

Joint Highway Research Project

Project: C-36-51B
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Lafayette, Indiana

August 10, 1966

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All airphotos used in connection with the preparation of this report automatically carried the following credit lines: "Photographed for Commodity Stabilization Service, Performance and Aerial Photography Division, United States Department of Agriculture."

Airphoto Interpretation of Engineering Soils of Owen County, Indiana

by
P. T. Yeh

INTRODUCTION

The Engineering soils map of Owen County, Indiana which accompanies this report, was compiled from 7-inch x 9-inch aerial photographs having an approximate scale of 1:20,000. The aerial photographs were taken in August 1939 in connection with the United States Department of Agriculture program.

Aerial photographic interpretation of the land forms and engineering soils of this county was accomplished in accordance with accepted principles of observation and inference (1)*. Soil samples were collected by the Soil Conservation Service and tested in the soil testing laboratory of Purdue University. Standard mapping symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to deliniate land forms and soil textures. The text of this report largely represents an effort to overcome the limitation imposed by adherence to a standard symbolism.

General soil profiles and engineering soil test data for the principle soils represented within Owen County were included on the map and within the report. These data show the general range of soil index properties but do not supplement detailed field surveys for specific engineering projects.

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* Figures in parentheses refer to references appearing in the bibliography.

Liberal reference was made to the "Soil Survey of Owen County" (2) and "The Formation, Distribution and Engineering Characteristics of Soils" (3). In many instances the agricultural soil survey did provide a convenient endorsement of the photo interpreter's judgment.

DESCRIPTION OF AREA

General

Owen County is located in the southwestern part of Indiana (Figure 1). The county has a shape of a sheared-off rectangle with the northern part offset to the east. The total area of the county is 391 square miles (2). Spencer is the county seat and the largest city. A population of 11,400 inhabitants resided within the county, with 2,557 reported for Spencer in the 1960 census (4).

According to the 1959 Census of Agriculture, there were 156,162 acres of farm land (about 63.4% of the county area) in Owen County (5). Wooded areas (about 52,078 acres in 1959) are generally confined to the steep slopes along streams and rivers as shown in Figure 2, especially in the sandstone-shale region.

Drainage Features

Owen County lies wholly within the drainage basin of West Fork White River which diagonally crosses the county on the southeast quarter (Figure 3). Fish Creek and Rattlesnake Creek, the major tributaries from the north and Raccoon Creek, main tributary from the east, all empty their water into West Fork White River within the county.

Lick Creek which drains the southwestern quarter and Mill Creek, collector of runoff from the northern part of the county, are tributaries of Eel River which in turn is a tributary of West Fork White River.

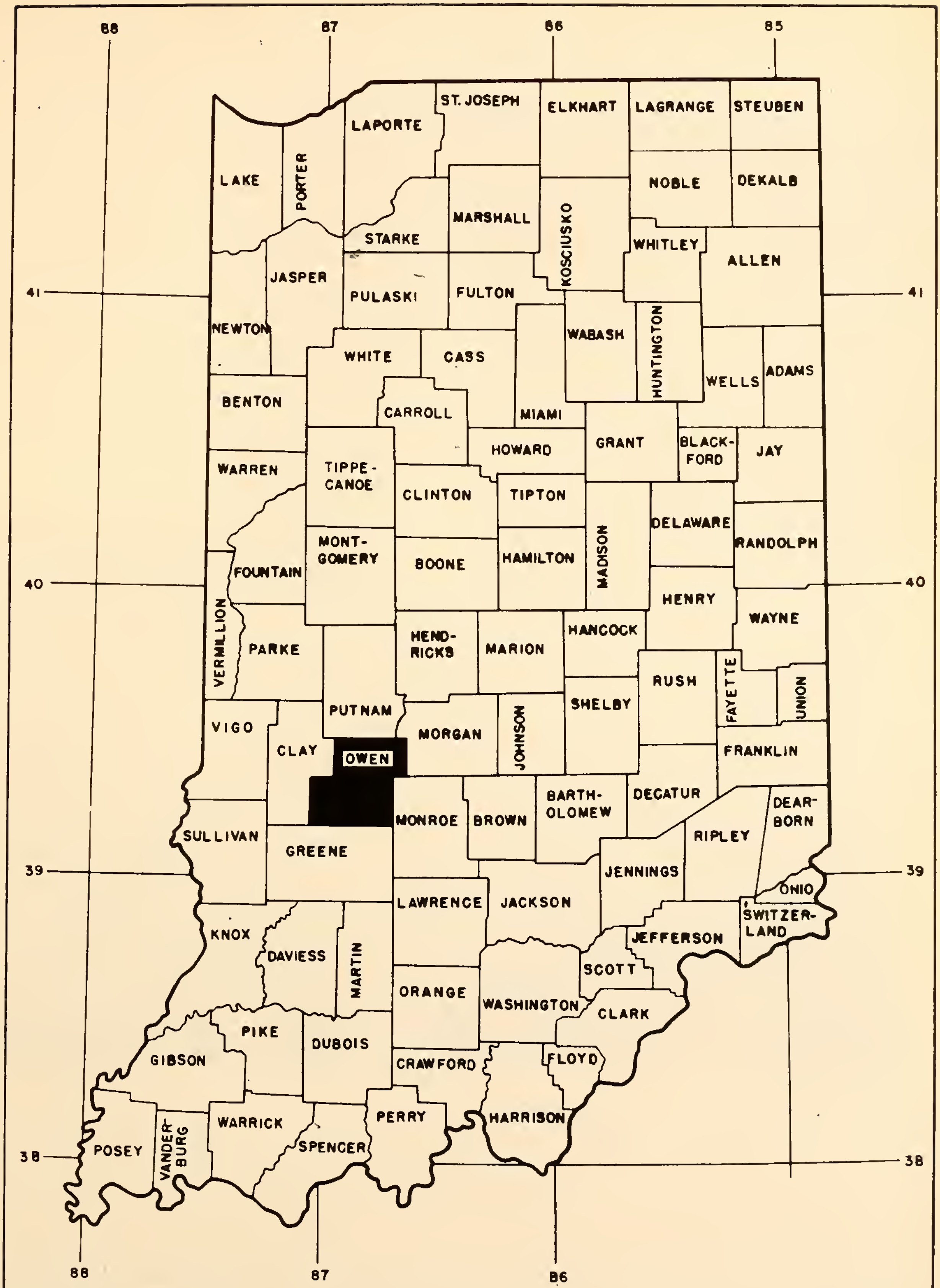
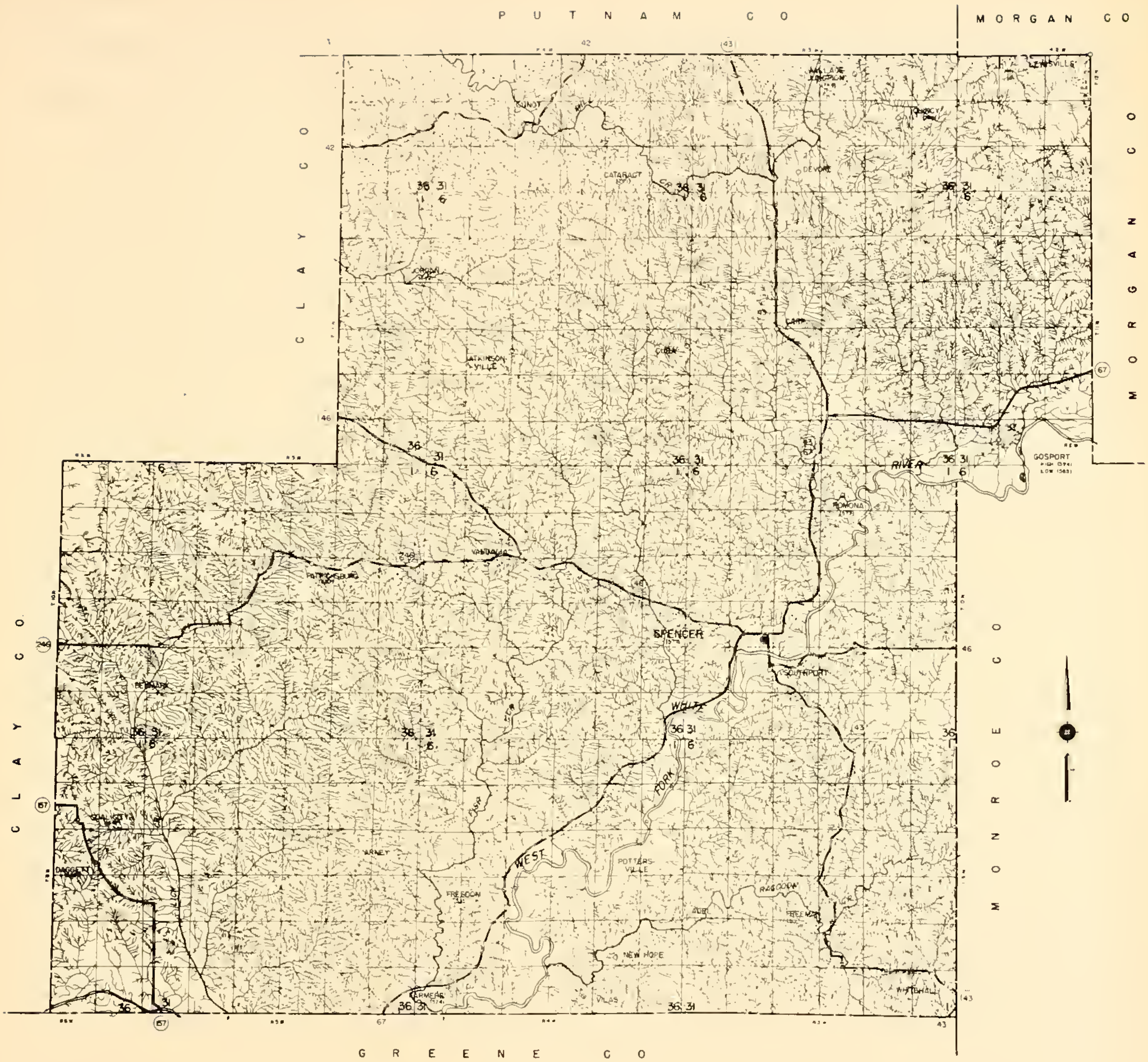


FIG I LOCATION MAP OF OWEN COUNTY

FIG. 2 AIRPHOTO MOSAIC OF OWEN COUNTY

FROM 1939 INDEX MAP



DRAINAGE MAP

OWEN COUNTY

INDIANA

PREPARED FROM

1939 AAA AERIAL PHOTOGRAPHS

BY

JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1949

FIG. 3

Eel River, however, only touches the county in its extreme southwestern tip before joining the West Fork White River about four miles south in Greene County.

There are no natural lakes in Owen County. Cataract Lake along Mill Creek in the northwestern corner is the largest man-made reservoir in the county. Others are located near Gosport and Atkinsonville for water supply purposes. Many small irregularly shaped ponds on the southwestern quarter of the county are a result of strip mining for coal.

Surface drainage is well developed on the upland in the central part of the county. Subterranean drainage is much in evidence in the eastern and southeastern part of the county where limestone occurs. In the western part the streams are rather sluggish and strip mines have disrupted the drainage system to a certain extent.

Geology variations affect the drainage feature greatly in Owen County. The considerably wide valley of the West Fork of White River suddenly narrows down when it encounters the rock ridges between Ramona and Spencer. Cataract Falls, in Mill Creek, are formed by ledges of limestone. The combined fall and rapid is nearly 100 feet. Falls also occur in McCormicks Creek a short distance from the junction with West Fork White River.

Climate

The climate of Owen County is continental, humid, and temperate. The warm humid summers and moderately cold winters are characterized by frequent sudden changes of temperature.

Since records of climate have been kept at Spencer for only a short time, the information about the climate for Owen County was obtained from records of Bloomington in Monroe County. Bloomington is nine miles east of the southeastern corner of Owen County.

The wide variations occurring within a season can be seen from the absolute minimum and maximum temperature listed on Table I. The average annual precipitation is 43.97 inches. The average amount of monthly precipitation is fairly uniform as shown in Table I (6).

Physiography

Owen County lies mainly within the Till Plains Section of the Central Lowland province of the United States. The south eastern corner, however, is included in the Highland Rim Plateau section of the Interior Low Plateaus Province (7).

Regionally, Owen County covers four physiographic divisions in Indiana. The western corner lies on the Wabash Lowland; the Central portion rests on the Crawford Upland, the eastern part belongs to the Mitchell Plain and a small area on the extreme southeastern corner is included in the Norman Upland (Figure 4).

Topography

The back bone of Owen County is a broad belt of hilly or dissected plateau region which is about six to ten miles wide and extends from the northwestern corner to the southeastern corner of the county (Figure 5). High hills and deep valleys alternate in close succession. The valleys are 180 to 250 feet deep from the ridge top. Level areas in this belt are limited to the ridge top and stream bottom. This hilly belt is bisected by the West Fork of White River. The highest point of the county (925 feet) is located at the northwestern quarter of Section 12, T11N. R4W. about two miles south of the upper Cataract Falls. The upper and lower Cataract Falls are three quarters of a mile apart near Cataract. These two falls have a plunge of 81 feet (8).

Table I

AVERAGES AND EXTREMES OF TEMPERATURE AND PRECIPITATION
AT BLOOMINGTON, INDIANA

Month	Temperature			Precipitation		
	Average °F	Absolute Maximum °F	Absolute Minimum °F	Average inches	Driest year 1963	Wettest year 1945
January	31.2	78	-20	3.87	1.14	0.89
February	31.2	76	-20	2.77	0.45	3.92
March	43.0	86	- 2	3.96	8.66	9.71
April	53.7	91	17	3.91	2.11	4.78
May	64.0	97	29	4.48	2.33	4.79
June	72.6	103	36	5.09	2.60	10.32
July	76.8	110	46	3.50	5.43	2.46
August	75.1	104	41	3.33	3.67	5.59
September	67.7	103	28	3.76	0.48	8.14
October	57.3	96	17	2.68	0.33	2.18
November	43.9	84	- 2	3.49	1.91	5.32
December	33.4	73	-11	3.13	1.00	2.62
Year	54.2	110	-20	43.97	30.11	60.72

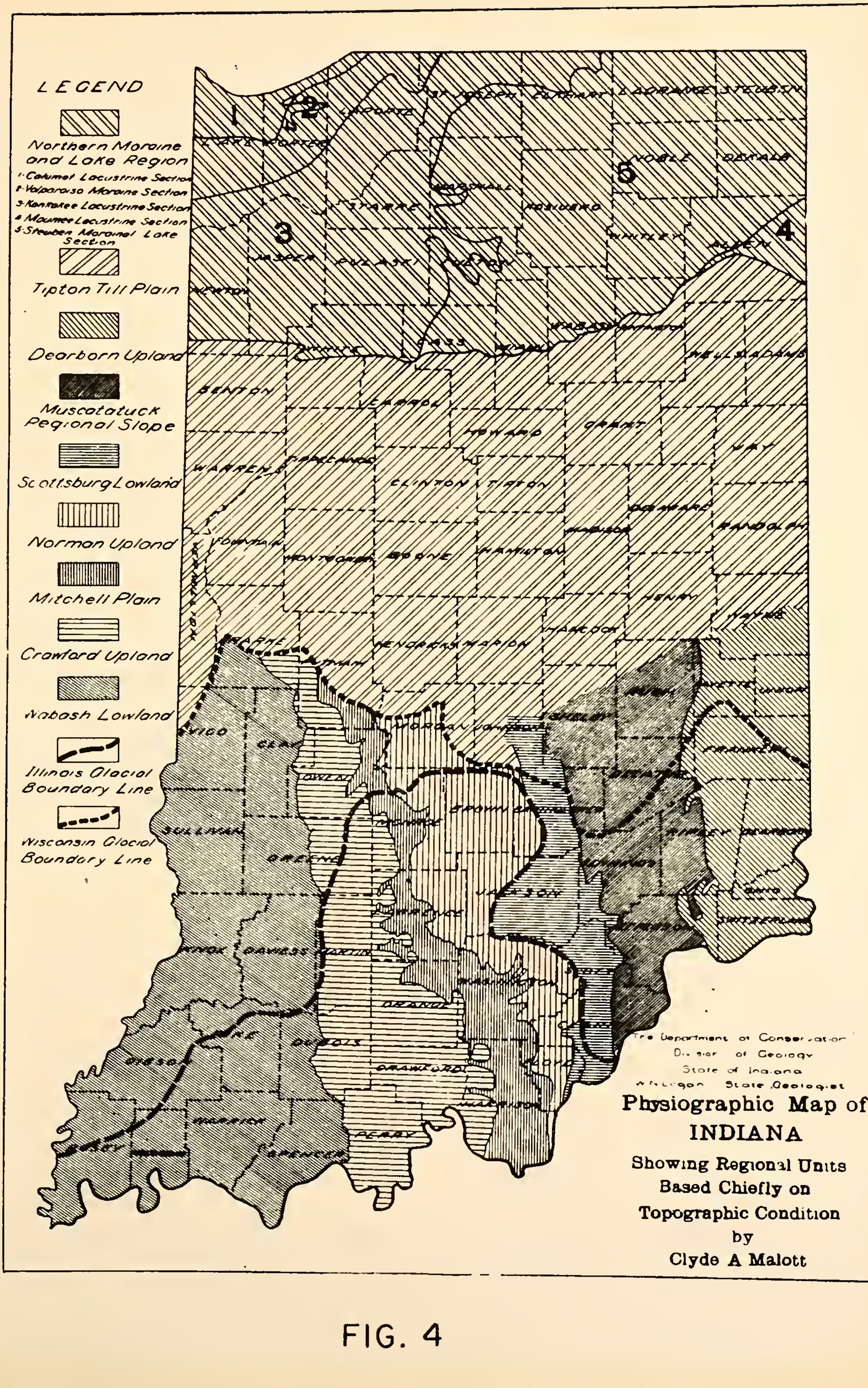
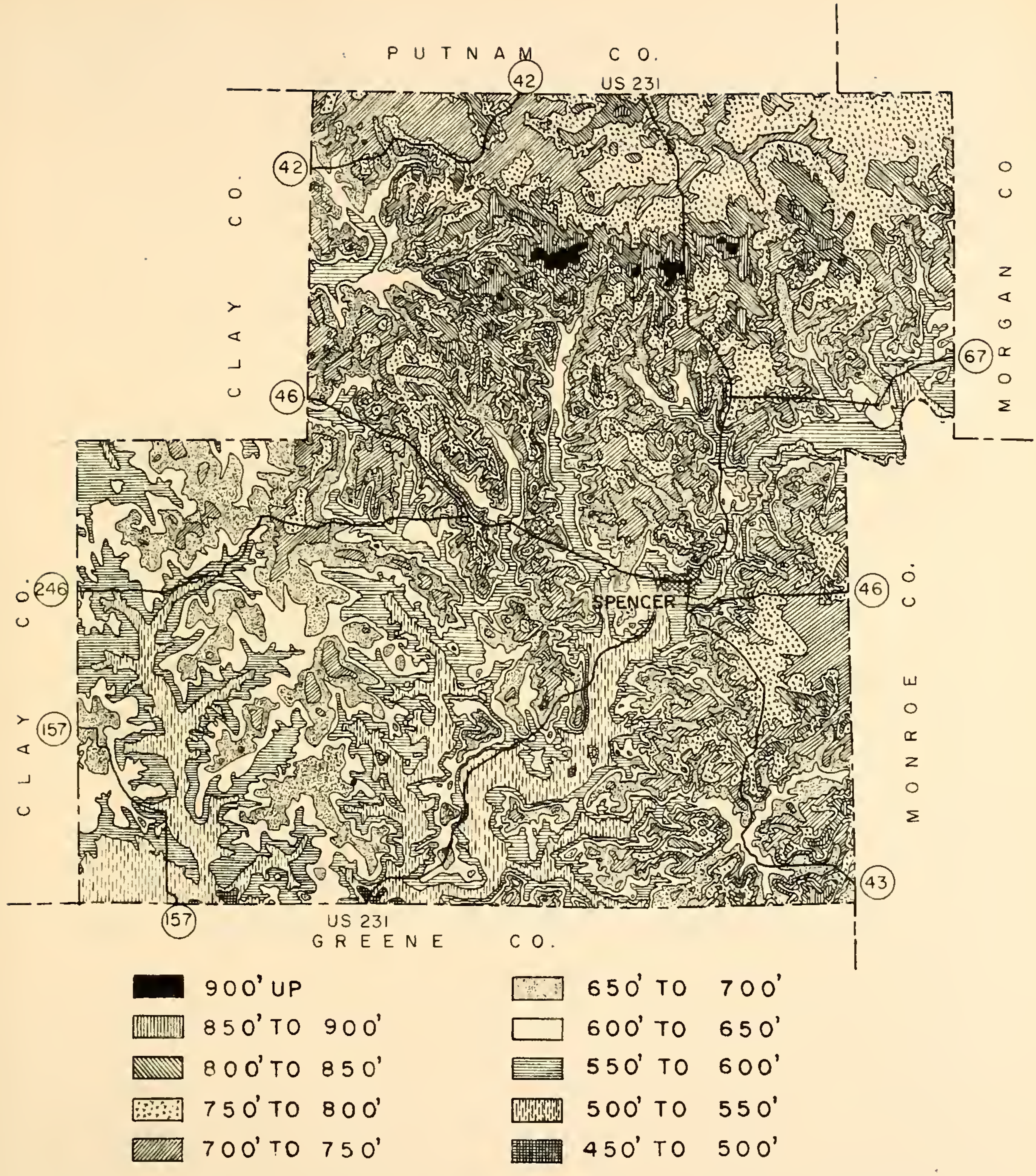

LEGEND
Northern Moraine and Lake Region
1-Calumet Lacustrine Section
2-Valparaiso Moraine Section
3-Kankakee Lacustrine Section
4-Maumee Lacustrine Section
5-Steuben Morainal Lake Section
Tipton Till Plain
Dearborn Upland
Muscatatuck Regional Slope
Scottsburg Lowland
Norman Upland
Mitchell Plain
Crawford Upland
Wabash Lowland
Illinois Glacial Boundary Line
Wisconsin Glacial Boundary Line
1
2
3
4
5
LAPORTE
NOBLE
DEKALB
MARSHALL
STARKE
JASPER
PULASKI
FULTON
WHITLEY
ALLEN
CASS
BENTON
CARROLL
HOWARD
GRANT
WARREN
CLINTON
TIPTON
BOONE
HAMILTON
DELAWARE
RANDOLPH
HENRY
WAYNE
HANCOCK
MARION
HENDRICKS
VIGO
CLAY
OWEN
SULLIVAN
GREENE
JACKSON
KNOX
DAVIESS
MARTIN
ORANGE
DUBOIS
GIBSON
CRAWFORD
PERRY
SPENCER
FRANKLIN
OHIO
SWITZERLAND
The Department of Conservation
Division of Geology
State of Indiana
State Geologist
Physiographic Map of INDIANA
Showing Regional Units Based Chiefly on Topographic Condition
by
Clyde A Malott

FIG. 4



DERIVED FROM THE INDIANAPOLIS (NJ 16-2) NATIONAL TOPOGRAPHIC 1° QUADRANGLES, SCALE 1/250,000

FIG. 5 TOPOGRAPHIC MAP OF OWEN COUNTY

(CONTOUR INTERVAL 50')

East of the hilly belt lies a broad undulating limestone plain. Sinkhole topography occurs. Local relief ranges from 10 to 20 feet. Subterranean drainage and caves are common in this area. However, there are a considerable number of surface drainage channels within this region. The valleys are generally about 50 feet below the adjacent surface. Deep incisions of 150 feet or more may be found close to the junction with West Fork White River near Gosport.

There are two extremely flat areas in Owen County. The larger one is located in the northeastern portion of the county and extends from Cataract in a northeastern direction to Morgan County and the other is situated on the eastern edge southeast of the West Fork White River. These surfaces were the glacial lacustrine plains formed during the Illinoian glaciation period (8). The elevation of the lacustrine plain in the north varies from 750 feet to 800 feet above sea level. The altitude of the eastern one ranges from 700 to 750 feet above sea level or about 130 feet higher than the flood plain of White River.

The southwestern portion of the county has a gently rolling topography. The high knobs and divides are much broader than the hilly belt that lies immediately to the east. Local relief of 100 feet or more is found along the dissected streams near Eel River at the southwestern corner. The lowest altitude of the county (below 500 feet) is on the Eel River near the county border with Greene County. Strip mining creates an unusual landscape within this region. Waste or spoil from the mining operation near Coal City exhibits, locally, a saw tooth topography and many elongated narrow ponds are found in this area.

Along the major rivers or streams, broad and nearly level flood plains are common. The minute relief in the flood plain is a result of current action. Terraces of lacustrine and fluvial origin are also found scattered

in the broad valley bottoms. The terraces are only slightly higher than the flood plain adjoining to them. Most of the terraces have an extremely level or smooth surface.

Geology

The geology of Owen County is composed of unconsolidated material deposited during the Quarternary period and the consolidated or bedrock formations of Mississippian and Pennsylvanian ages. Although nearly the entire county was invaded and covered by Illinoian glaciation (Figure 6), rock outcrops are found in almost all parts of the county. Because of the deep incision of the drainage channels, rocks of different formations or ages may be exposed on the valley walls.

The geologic formations of Owen County are illustrated in Figure 7. Since the rock strata is tilted in a south-southwestern dip of from 30 to 50 feet per mile (8), the older formations outcrop in the east and the younger deposits are exposed to the west.

The oldest rock outcrop in the county is the Borden group of the Mississippian system. The group is composed of siltstone, shale and argillaceous sandstone. The outcrop occurs in small areas. One is located near the southeastern corner of the county and the other lies in the northeastern quarter about three miles north east from Gosport.

The area east of Spencer is underlain by Harrodsburg, Salem, St. Louis and Ste. Genevieve limestone formations, subdivision of the Meramec series of the Mississippian system. Immediately west on the hilly belt lies the lower Chester group which includes the Aux Vases and Paoli limestone, Bethel sandstone, Beaver Bend limestone, Sample sandstone, Reelsville limestone, Elwren sandstone and Beech Creek limestone formations.

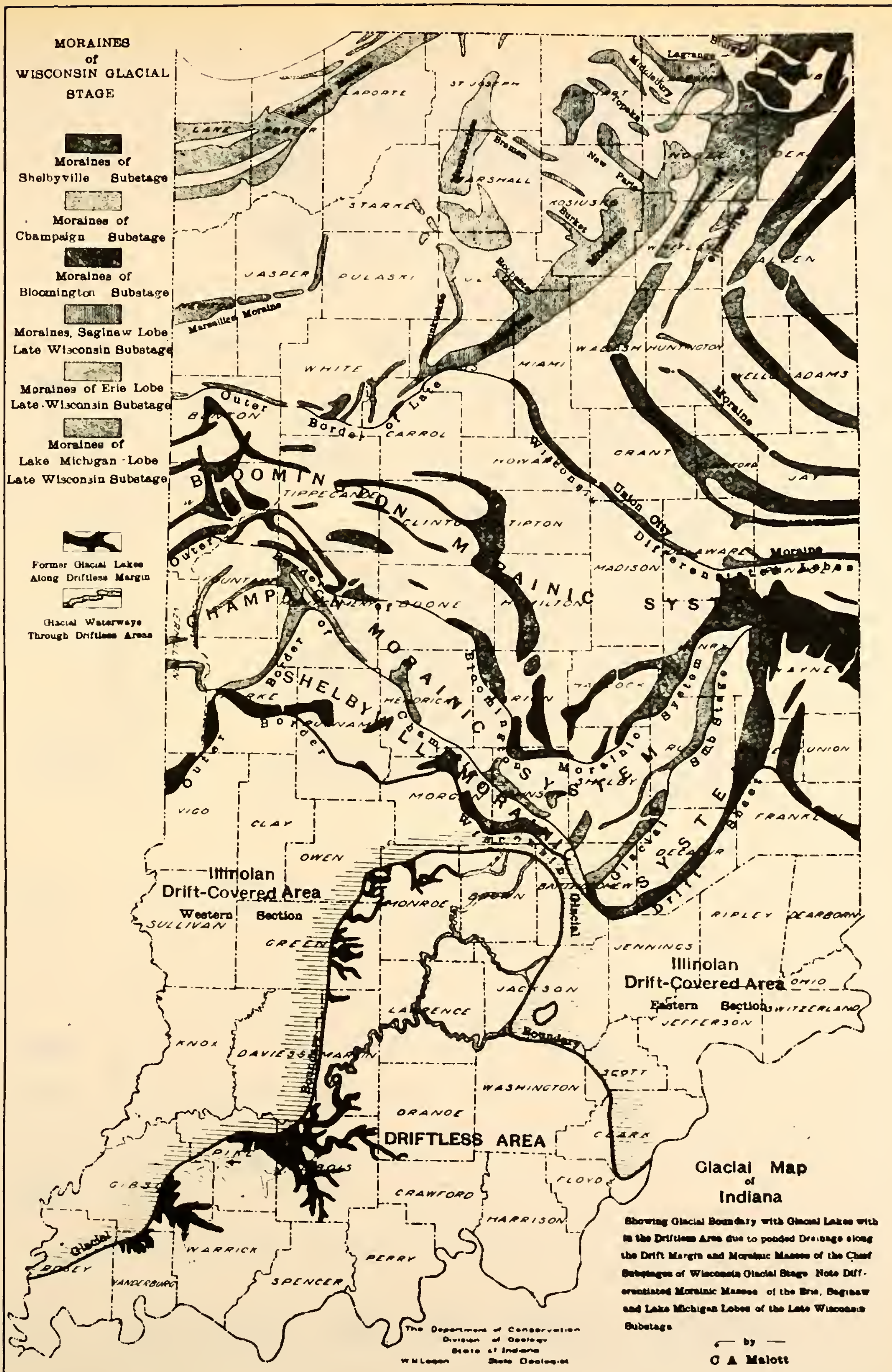
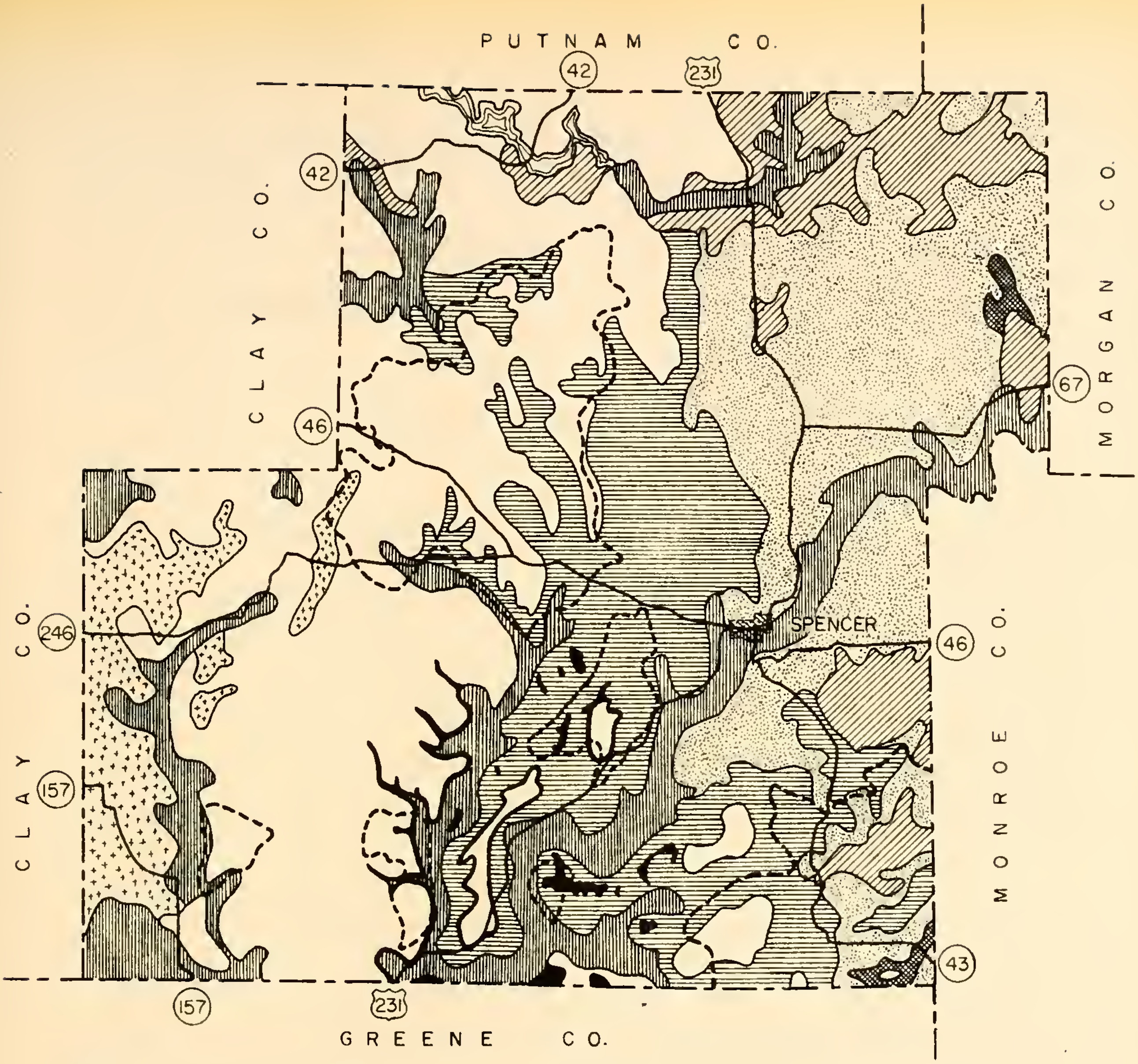

MORAINES of WISCONSIN GLACIAL STAGE
Moraines of Shelbyville Subetage
Moraines of Champaign Subetage
Moraines of Bloomington Subetage
Moraines, Saginaw Lobe Late Wisconsin Subetage
Moraines of Erie Lobe Late-Wisconsin Subetage
Moraines of Lake Michigan Lobe Late Wisconsin Subetage
Former Glacial Lakes Along Driftless Margin
Glacial Waterways Through Driftless Areas
BLOOMINGTON MORAINIC SYSTEM
CHAMPAIGN MORAINIC SYSTEM
SHELBYVILLE MORAINIC SYSTEM
Illinoian Drift-Covered Area Western Section
Illinoian Drift-Covered Area Eastern Section
DRIFTLESS AREA
Outer Border of Late Wisconsin
Union City Moraine
Differentiated Lobes
Glacial Boundary
Marseilles Moraine
Bremen
New Paris
Burket
Topeka
Middlebury
Lagrange
LAPORTE
ST JOSEPH
LAKE
PORTER
STARKE
MARSHALL
KOSIUSKO
JASPER
PULASKI
WHITE
MIAMI
WABASH
HUNTINGTON
ADAMS
CARROL
GRANT
HOWARD
TIPPECANOE
CLINTON
TIPTON
MADISON
HAMILTON
BOONE
DELAWARE
WAYNE
HENDRICKS
UNION
FRANKLIN
MORGAN
SHELBY
DECATUR
VIGO
CLAY
OWEN
MONROE
BROWN
SULLIVAN
GREENE
JENNINGS
JACKSON
LAWRENCE
OHIO
SWITZERLAND
JEFFERSON
KNOX
DAVIESS
MARTIN
SCOTT
WASHINGTON
ORANGE
CLARK
PIKE
DUBOIS
GIBSON
FLOYD
CRAWFORD
HARRISON
WARRICK
PERRY
POSEY
VANDERBURG
SPENCER
RIPLEY
DEARBORN
Glacial Map of Indiana
Showing Glacial Boundary with Glacial Lakes within the Driftless Area due to ponded Drainage along the Drift Margin and Morainic Masses of the Chief Subetages of Wisconsin Glacial Stage Note Differentiated Morainic Masses of the Erie, Saginaw and Lake Michigan Lobes of the Late Wisconsin Subetage
by
C A Malott
The Department of Conservation
Division of Geology
State of Indiana
W N Logan State Geologist

FIG. 6



ALLUVIAL AND VALLEY DEPOSITS: SILT AND CLAY WITH SOME SAND AND GRAVEL OVERLAIN BY A VENEER OF ALLUVIAL DEPOSITS.

LAKE DEPOSITS: SILT AND CLAY, UNDERLAIN BY SOME SAND AND GRAVEL.

BRAZIL FORMATION: CLAY, COAL, SHALE, AND LIMESTONE.

MANSFIELD FORMATION: SANDSTONE QUARTZ CONGLOMERATE, SHALE, AND SOME LIMESTONE, CLAY, AND COAL.

BIG CLIFTY THROUGH GLEN DEAN FORMATION: SANDSTONE, SHALE, AND LIMESTONE.

AUX VASES THROUGH BEECH CREEK FORMATIONS: LIMESTONE, SHALE, AND SANDSTONE.

HARRODSBURG, SALEM, ST. LOUIS, AND STE. GENEVIEVE FORMATIONS: LIMESTONE AND SOME SHALE.

BORDEN GROUP: SANDSTONE, SILTSTONE, AND SHALE.

BROKEN LINES ENCLOSE AREAS LITTLE AFFECTED BY GLACIATION

FIG. 7 GEOLOGIC MAP OF OWEN COUNTY

The limestone formations in this group are relatively thin. The shales are interbedded in the various sandstone formations (9).

The middle Chester group which consists of Big Clifty sandstone, Golconda limestone, Hardinsburg sandstone and Glen Dean limestone, is confined to a very narrow band near the valley of Fish Creek and the Green County border. Outcrops of the Upper Chester group do not occur in Owen County.

Mansfield sandstone formation, a subdivision of Pottsville Series of the Pennsylvanian system, occurs in the western half of Owen County. Some remnants, however, are scattered amidst the area occupied by the lower Chester Series in the southern third of the county. The Mansfield formation is a crossbedded to massive coarse-grained, some times pebbly, sandstone and silty shale. Locally there are conglomerates and thin beds of limestone and coal (9).

On the southwestern corner of Owen County lies the Brazil formation, a subdivision of the Pottsville Series. This formation is composed of a number of coal measures, shales, clays and limestones. Lower Black Coal, Upper Black Coal, Minshall Coal, Minshall limestone and Coal II are the members of the Brazil formation.

As mentioned previously, nearly the entire county is covered or influenced by Illinoian glacial drift. This is the unconsolidated sands, silts, clays and gravels deposited during the Pleistocene period of the Quaternary system. The glacial lacustrine plains and the Illinoian ground moraine areas are under this category. Along the drainage channels the unconsolidated deposits are recent in age and are composed of sands, silts, and gravels. They were deposited by fluvial action. The surface soil

of the entire county is also influenced to a certain extent by a blanket of eolian deposits of loess which varies in thickness from nothing to 50 inches or more.

The geological formation of Owen County may be summarized as follows:

Quaternary	Unconsolidated silts, clays, sands and gravels (recent). Unconsolidated silts, clays, sands, and gravels (Pleistocene)
Pennsylvanian	Clays, coals, shale and limestone (Brazil formation). Sandstone, quartz conglomerate, shale and some limestone clays and coals (Mansfield formation)
Mississippian	Limestone (Glen Dean formation)
Middle Chester Group	Sandstone, shale, (Hardinsburg formation)
	Limestone, shale, sandstone (Golconda formation)
	Sandstone (Big Clifty formation)
Lower Chester Group	Limestone (Beech Creek formation)
	Sandstone, shale (Elwen formation)
	Limestone (Reelsville formation)
	Sandstone, shale (Sample formation)
	Limestone (Beaver Bend formation)
	Sandstone, shale (Bethel formation)
	Limestone (Paoli and Aux Vases formations)
Meramac Group	Limestone (Ste. Genevieve formation)
	Limestone (St. Louis formation)
	Limestone (Salem formation)
	Limestone (Harrodsburg formation)
Bordon Group	Sandstone, siltstone & shale (Harrodsburg formation)
	Limestone (Harrodsburg formstion)
	Siltstone, sandstone & shale (Edwardsville formation)

LANDFORMS AND ENGINEERING SOIL AREAS

Engineering soils in Owen County are derived both from unconsolidated and consolidated materials. The surface soils in this county, however, are influenced by a thin layer of windblown silt or loess. The unconsoildated materials include glacial drift of the Illinoian age, glacial-fluvial outwash deposits, lacustrine deposits, alluvial deposits and eolian deposits.

Since the deposits of transported materials are far from homogeneous, variation should be expected. Even in residual soil areas, rock composition as well as their stratigraphy are far from uniform. Therefore, only general properties and profile of the soil for each area of different landform are presented in this report. The soil samples were collected by the Soil Conservation Service, the horizons obtained are more specific than those obtained for engineering purposes.

Glacial Deposited Materials

The major portion of Owen County is covered by Illinoian glacial deposits. The thickness of the drift deposit has a profound affect on the soil profile development. The glacial deposits are subdivided into three groups, namely: the Illinoian till, the thin Illinoian drift over limestone and the thin Illinoian drift over sandstone-shale. They are discussed as follows:

1. Illinoian Till Plain

The areas designated as Illinoian Till Plain are scattered throughout Owen County. The largest area is located in the southwestern section of the county. A large area is also located in the northwestern corner north of Cataract. Another area of about nine square miles in size is situated northwest of Spencer. The general topography of this till plain varies from nearly level to undulating. However, erosion by surface streams has created a gently rolling topography. Most of the nearly level to moderately sloped areas are under cultivation (See Fig. 2). Because of the workable coal measures underneath the Illinoian drift in the southwestern portion of the county, many strip mines are operated in this area.

The depth of the Illinoian glacial drift varies from less than 20 to 50 feet or more. Because of its relatively old age, weathering or leaching of the Illinoian till reaches to a depth of 10 feet or more. The surface of this soil area is covered by a blanket of loess from 10 to 70 inches in thickness.

The surface soil of the Illinoian drift has a silt loam texture. The subsurface soil varies from silty clay to clay. On steep slopes where erosion is severe, the topsoil may have been removed and the subsurface soil exposed. These upper layers of the soil profile are developed from the loess material. A layer of clay is found immediately below the subsurface soil and the leached till with a clay loam texture lies below. The general composition of the till, derived from test data of sites 5, 6, 7, 25, 26 and 27 (see Table II), consists of approximately 30% sand, 45% silt and 25% clay. The calcareous clay loam till may be found at a depth from 10 to 12 feet beneath the surface.

The engineering problems associated with these soil areas are those of low strength when wet, difficulty of compaction, drainage and erosion of side slopes. In the strip mining areas loose debris of a mixture of drift and rocks may create engineering problems. On severely eroded surfaces bedrock may be encountered at a shallow depth from the surface.

2. Thin Illinoian Drift Over Limestone

The thin Illinoian drift over limestone area is concentrated in the northeastern section of Owen County. Some smaller areas, however, are scattered in the eastern part of the county.

The topography of this area is mainly a gently undulating, sinkhole studded, plain. Steep slopes are found around the sinkholes and drainage channels. This area is extensively farmed (see Fig. 2) because of its favorable topography.

The soil of this area is developed in loess underlain by weathered glacial drift over material weathered from limestone. The thickness of the loess varies from 10 to 50 inches. The thickness of till ranges from a few inches to 36 inches or more. Limestone bedrock is found from three to eight feet from the surface.

The soil profile of this area consists of a silt loam topsoil and a clayey subsurface soil. On steep slopes where erosion is severe the silt loam topsoil may be removed and the clayey subsurface soil exposed. The subsurface soil is underlain by sily clay and then silt loam derived from the Illinoian drift. Before the unweathered limestone bedrock is reached a layer of red clay is encountered. This layer of highly plastic clay is the result of the weathering of the limestone.

Sinkhole topography will create fill and stability problems for the highway engineers. Limestone rock may be expected in shallow cuts. There are a number of caves in this region: Porter cave is located near the Morgan County border in SE¼ of Sec. 33, T12N., R2W; Rogers cave is situated near the center of Sec. 5, T11N., R2W; and Wolf cave in McCormicks Creek State Park in the NW¼ of Sec. 14, T10N., R3W.

3. Thin Illinoian Drift Over Sandstone-Shale

The thin Illinoian drift over sandstone-shale areas are located mostly in the central section of Owen County. The larger areas lie close to Cuba and Freedom. They are generally situated in the transitional position, i.e., with Illinoian drift on one side and the sandstone-shale region on the other.

The topography in these areas is more rolling than the Illinoian till plain but much less rugged than the sandstone-shale region. The surface appears smooth and divides are broader. The surface drainage is

influenced by the underlying bedrocks.

The soil of this area is developed from a blanket of loess underlain by weathered drift over sandstone-shale. The upper soil profile of the area is essentially the same as the soil of the Illinoian till plain. The weathered clay loam drift material is resting on top of sandstone-shale at a depth from about four feet to 20 feet, depending on the pre-glacial erosional condition of the bedrock.

Problems in this area are those of seepage, compaction control and erosion of side slopes. Sandstone-shale bedrock may be encountered in shallow cuts.

Residual Soils

Residual soils or colluvial soils in Owen County occupy an area of about 60 square miles. The truly residual soils occur only in the southeastern corner of the county where glaciation did not invade the area. Others occur in the central portion of the county (see Fig. 7) where the glacial materials might have been entirely removed by subsequent erosion after the Illinoian glacial period. The residual soils in this county are subdivided into three types, namely: the limestone soil, the sandstone-shale soil and the sandstone-shale over limestone soil. Details are discussed as follows:

1. Limestone

The limestone soil areas occur in the southeastern corner of the county adjacent to Raccoon Creek. The total area is about three square miles. Sinkhole topography unmistakenly reveals this soil area. Surface drainage systems are almost entirely absent in this region.

Even though the area was not subjected to glaciation, the surface is covered by a veneer of loess. The thickness of the loess ranges from 18 to 48 inches. The soil of this area (site numbers 1, 2 and 3) consists of a silt loam topsoil, a silty clay subsurface soil and a clayey subsoil. The first two horizons are the result of weathering of loess. On steep slopes where erosion is severe these two layers may be removed entirely and the red colored, highly plastic clayey subsoil may be exposed. Since the limestone of this region has a high chert content, chert fragments are found throughout the profile.

The engineering problems in this area are likely to be rock cuts and problems associated with the sinkholes.

2. Sandstone-Shale

The sandstone-shale soil is the major residual soil of Owen County. The main body of this soil occurs near Atkinsonville. The remainder is scattered in the southern half of the county. As mentioned previously, only the areas in the southeastern corner of thé county were not affected by glaciation. The other areas are situated amidst the glacial region but show little affect of glaciation.

The topography of this soil region is extremely rugged. Hills and valleys are closely spaced with great local relief. Flat lands are limited to the narrow ridge tops and the flood plains of the deep valleys. Most of the area is used for timber lands.

The soils developed in this area are derived from a blanket of silt (18 to 48 inches in thickness) snd the underlying interbedded sandstone-shale. The soil profile is complicated by the erosional condition. On steep slopes where the silt cap has been entirely removed a stony silt loam may be found and sometimes the underlying unweathered interbedded

sandstone-shale may be exposed at or near the surface. Under the normal condition, a silt loam topsoil is developed on the surface and followed by a subsurface soil of silt loam or silty clay texture. The silt loam or loam subsoil is the result of weathering of the sandstone-shale bedrock. Immediately above the unweathered bedrock there is a layer of weathered rock with a texture ranging from sandy loam, to clay mixed with many rock fragments. The variation of the texture in this layer depends entirely on the bedrock. The clayey texture is developed from shale bedrock and the sandy loam or loam is from the sandstone bedrock.

The engineering problems are associated with deep cuts and fills in different types of bedrock. The soil is susceptible to frost heaving and significant seepage problems occur in the interbedded sandstone and shale.

3. Sandstone-Shale Over Limestone

A few small areas in Owen County are classified as sandstone-shale over limestone area. The largest one is located at the southeastern corner of the county. Several small ones are scattered near Arney and Freedom.

The topography of this area is hilly and as rugged as the sandstone-shale area. However, some sinkhole indentations are clearly seen on the surface (Fig. 8). This adds considerable roughness to the local relief.

The soil developed in this area is derived from the thin sandstone-shale strata underlain by limestone. The surface soil, however, is influenced by the thin loess (about 30 inches) cover. The upper part of the soil profile is essentially the same as in the sandstone-shale area. The only difference lies on the lower part of the soil profile. The loam and clay subsoils which follow the silt loam and silty clay are attributed

to the sandstone-shale bedrocks. The weathered sandstone and shale provided a layer of sandy loam or clay loam with numerous fragments of rocks. The limestone bedrock lies immediately beneath the sandstone and shale.

The engineering problems of this soil area deal chiefly with cuts and fills within different kinds of rocks.

Water Deposited Materials

Extensive areas of water deposited materials exist in Owen County. Four different types of landforms created by the action of water, namely: outwash plain, terrace, lacustrine plain and alluvial plain are discussed as follows:

1. Outwash Plains

About 35 square miles of Illinoian outwash plains exist within Owen County. The outwash plains are concentrated at two points within the county. The major one extends south of Carp through Ramona, Spencer, Southport and terminates at Freeman. The other large area lies in the northwestern corner west of Cataract and north of Jordan. A few smaller ones are scattered along the major streams or creeks particularly along Rattlesnake Creek.

The topography of the Illinoian outwash plain varies from nearly level to highly dissected. The airphoto interpretation elements such as infiltration basins, current scars and the flatness of the plain which are outstanding characteristics of younger outwash plains are entirely absent. Due to the older age of the deposit, surface drainage is well developed and erosion has carved the once nearly level plain into a highly dissected area (see Fig. 9). Forestry is the major agricultural land use in the region of steep slopes (see Fig. 2.).

FIG.8 AIRPHOTO PATTERN OF SANDSTONE-SHALE OVER LIMESTONE

Soils developed in this area are derived from a loess blanket with a thickness ranging from less than 18 inches to about 60 inches and the underlying sandy outwash material. The outwash deposits vary in depth from 20 feet to more than 100 feet and the composition is mainly sands with a small amount of gravels.

The soil profile consists of a surface material that varies from a sandy loam to a silt loam. The subsurface soils are somewhat more clayey in texture, ranging from loam to silty clay. The subsoil is a less plastic sandy loam or silt loam. The stratified waterlaid sands and gravels are found from about 3 to 6 feet below the surface. The depth of leaching of this soil is about 15 feet.

2. Terraces

Two types of terraces occur in Owen County. They are the granular terrace and the slack water terrace. The detail of each is discussed as follows:

(a) Granular Terraces

The granular terraces are confined exclusively along West Fork White River. Spencer, the county seat, is located on the largest terrace. The next from the largest one is located on the north side of the river near the border of Morgan County east of Gosport.

The nearly level terraces are low terraces. They are only about 10 to 20 feet higher than the bottom land adjacent to them. In the rural areas infiltration basins and current scars are visible. The break between the upland and the terrace is clearly defined.

The soil profile on the granular terrace consists of a loam to silt loam topsoil underlain by a clay loam or a silty clay loam and then a gravelly loam to a sandy clay loam subsoil. The parent material is, in

FIG. 9 AIRPHOTO PATTERN OF ILLINOIAN OUTWASH PLAIN

general, a stratified sand and gravel. However, in some areas stratified silt and sand may be found. Sand texture is predominant in these terrace deposits.

(b) Slack Water Terraces

A few small areas along Raccoon Creek, Fish Creek and Eel River are classified as slack water terraces. The largest one is located along the Eel River valley near the northwestern corner of the county. A sizable one lies along Raccoon Creek from Adel to New Hope.

The slack water terraces are extremely flat. They are slightly higher (less than 10 feet) than the adjacent flood plain and have a smooth surface. Infiltration basins and current scars are missing in these terraces. Surface drainage is not very well developed. Surface channels are widely spaced.

The soils of the slack water terraces are developed from stratified silt, clay and fine sand. The materials are washed down mainly from sandstone-shale and Illinoian drift areas and deposited in a relatively slow moving water.

The soil profile on this terrace consists of a silt loam topsoil and a plastic silty clay loam subsoil. The lower portion of the subsoil contains less clay than the subsurface soil (see Table II, sites #12 and #13). The stratified parent material varies greatly in texture from place to place. The strata may contain a silty clay loam, loam, silt and some fine sand.

The major engineering problems associated with this area are the highwater table and occasional overflow.

3. Lacustrine Plains

There are about 30 square miles of lacustrine plains in Owen County. They can be subdivided into three types, namely: the loess covered lacustrine plain, the fine textured lacustrine plain and the highly organic topsoil, lacustrine plain. Details of each type are discussed as follows:

(a) Loess Covered Lacustrine Plains

The major portion of the lacustrine plain deposits in Owen County belongs to this type. The deposit is fairly well distributed over the entire county. The larger areas, however, are located in the northern section where glacial lake Quincy once occurred and on the southeastern corner where glacial lake Flatwoods lay (8). Smaller areas are scattered along Fish Creek, Lick Creek and Jordan Creek.

The topography of the lacustrine plain is a nearly level plain broken only by widely spaced drainage channels. Except in the gully or channel areas, the plains are intensively farmed. White fringes around the gullies reveal the presence of loess covering material which overlies the fine textured lacustrine deposit. Bedrock is buried 20 to 50 feet or more by these deposits.

Soils of these lacustrine plains are developed from a blanket of loess material, ranging from 10 to 60 inches in thickness, and the underlying stratified lacustrine deposit. The topsoil of this area varies from a silt loam to a silty clay loam. The subsurface soil is silty clay to clay in texture. A clay loam layer may be encountered before reaching the stratified parent material. The texture of the stratified lacustrine deposit varies from place to place. Clay, clay loam, silt, silty clay and fine sandy loam are the possible materials of these deposits (see test sites number 16 and number 21).

Because of the poorly drained situation in some areas, frost heave and weak supporting power are the major problems.

(b) <u>Fine Textured Lacustrine Plains</u>

A few small areas in Owen County are classified as fine textured lacustrine plains. They are scattered along West Fork White River near Gosport, Spencer and Farmers and also along Eel River at the southwestern corner of the county.

These lacustrine plains have a nearly level topography. The surface is smooth and flat (6 to 10 feet above the flood plain) interrupted by occasional surface channels. The surface also shows a more uniform dark tone than the loess covered lacustrine plains.

Most of the soils are developed from a fine textured lacustrine deposit. In some areas, however, a very thin loess of 6 to 12 inches in thickness may be present. The top soil, therefore, varies from a silt loam to a silty clay loam and even clay in texture. The subsoils are a very plastic silt clay or clay. The parent material is a stratified clay and silt with occasional thin layers of fine sand. Data from test site #14 reveals that the parent material is composed of 61% clay, 33% silt and 6% of sand.

Engineering problems in this area are associated with the highly plastic characteristic of the soil. In some areas where the drainage position is poor, a high water table is likely to occur. The combination of these two unfavorable factors will creat a poor subgrade problem for highways.

(c) <u>Highly Organic Topsoil, Lacustrine Plain</u>

Only a limited area located at the southwestern corner of the county is considered in this category. The area is situated next to the Eel River flood plain. It is slightly lower than the lacustrine plains to the north and somewhat higher (6 to 10 feet) than the flood plain on

the south.

Topographically speaking, the area is situated in a slight depression. The soil is very dark in color and the smooth surface is absent of any kind of surface drainage.

The soil is developed in a swamp under a mixed deciduous forest and marsh grass. The top silty clay loam or silty clay soil contains a high percentage of organic material. The subsurface soil is silty clay in texture with little organic matter. The subsoil is a very plastic clay. Stratified clay and some silt are found in the parent lacustrine deposits about two feet beneath the ground surface. More coarser materials may be found with depth as illustrated in test site number 29.

Engineering problems in this area are chiefly the high water table and ponded situation. The highly plastic nature of the soil makes it an unsatisfactory subgrade for all pavements.

4. Alluvial Plains

All drainage channels in Owen County possess recent alluvial plains or flood plains. However, the extent of mapping of these plains was determined by the scale of the engineering soils map. The larger alluvial plains are associated with the West Fork White River, Fish Creek, Lick Creek, Eel River and Jordan Creek. The widest alluvial plain (about one mile in width) is located along Eel River at the southwestern corner of the county. The wide alluvial plain along the West Fork of White River is narrowed down tremendously between Ramona and Spencer where the river cuts through rock. Continuous flood plains are best exhibited along Lick Creek and Fish Creek.

Most of the alluvial plains have flat to nearly level surfaces. Natural levees are developed along a portion of the large streams. Special features such as current markings, meandering stream channels, oxbows and

abandoned channels are plentiful along the major streams in Owen County.

The texture of the alluvial deposits varies greatly both horizontally and vertically from one place to the other. The texture of the deposit depends mainly on the nature of the drainage basin. Coarse textured deposits are found along the West Fork White River, Eel River and Mill Creek especially on the natural levees. Loam textured soil occurs near the main channel while silt loam becomes more prominent toward the valley walls. Silty clay loam soils are concentrated in old swales.

The variability of the soil profile is shown in the soil profile. The texture of the surface soil ranges from fine sandy loam to loam, silt loam and silty clay loam. The subsurface soils are also extremely variable. Sandy loam, silty clay loam or silty clay may be encountered. The material may become more coarse with increases of depth. Stratified sand and gravel may be found in areas close to the main channels, whereas in other areas stratified loam, silt loam, fine sandy loam and silt are most common.

The alluvial soil actually has little profile development other than the constant accumulation of washin materials, (See data on test sites number 8, 9, and 10). Flooding is the major problem in this area. Subgrade support is poor during wet seasons.

Eolian Deposited Material

Extensive eolian deposits occur in Owen County. They are subdivided into two groups namely: loess mantle deposits and sand dune deposits.

Nearly the whole county is covered by a thin mantle of loess. As mentioned previously, the mantle varies in depth from 10 to 50 inches or more with occasional depths to 70 inches. Since the blanket is rather

uniform and comparatively thin, only the top part of the soil profile is subject to its influence. The discussion of this loess mantle is not treated separately but included with the other landforms previously discussed.

The sand dune deposits are subdivided into two types namely: sand dune and shallow dune on sandstone-shale.

(a) Sand dunes

The sand dune deposits in Owen County are confined to the major river valleys. Most of them are scattered along West Fork White River with the larger areas near Gosport and Freedom. A few smaller sand dune areas are located along Eel River Valley near the southwestern and the northwestern corners of the county.

The sand dunes in these areas are irregular in shape and exhibit softly rolling to hilly topography. Hummocky landscape may appear in places.

Soils developed in this area are derived from windblown sands and in places mixed with windblown silts. The deposit may have a thickness of 20 feet or more. The surface soil varies from loam to sandy loam or sand. If silt is in high proportion, a silty clay subsurface soil may be found. Otherwise, it is underlain by a sandy clay loam subsurface soil and followed by a sandy loam subsoil before reaching the windblown fine sand deposit. Data collected from sites number 4 and number 20 show a sand content of about 90%.

Little or no problems other than stabilization and compaction are expected in this area.

(b) Sand Dune Over Sandstone-Shale

An area located about one mile north of Pottersville on the east bank of West Fork White River is considered as shallow sand dunes over

sandstone-shale. The topography is hilly to rugged and no regular dune shape can be observed.

This deposit is a sand silt mixture. The windblown materials attain their thickest depth on the northwestern part and thins gradually to the southeast on the sandstone-shale bedrock.

The top soil of this area varies from loam to sand. The subsurface soil may contain a little more clay and designated as a sandy clay loam. The subsoil becomes a more open sandy loam and a layer of slightly higher clay content sandy clay loam is generally encountered before reaching the interbedded sandstone-shale bedrock.

Cumulose Material

Four small areas in Owen County are designated as cumulose deposits or muck. Three are located on the alluvial plain north of Jordan. A small one lies on a flood plain about one mile east of Vandalia. The muck deposit is situated in a slight depression. The surface reflects a dark tonality and some swampy appearance.

Muck has developed from decomposed woods, grasses and sedges in the marshes or ponded areas. It consists of 12 to 42 inches of well-decomposed black colored organic matter in the upper horizon. Partly decomposed woody fragments mixed with fibrous material from grass, reeds, and sedges occur in the lower part of the profile. The underlying material is a friable calcareous loam. In some areas, especially those near the edges of the deposit, the uppermost 5 to 10 inches contains much silty material which was washed in from the adjacent land.

This is the poorest type of soil that the engineer may encounter within Owen County. Replacement should be made for all engineering structures.

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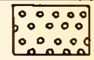
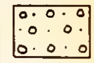
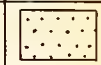
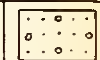
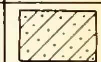
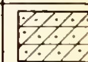
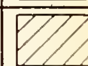
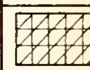
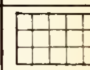
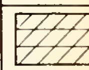
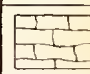
APPENDEX

SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution				Plastic Index	Symbol
	Gravel % Retained on #10	Sand #10–#200	Silt 0.05–0.005mm	Clay Less than 0.005mm		
Gravel	85–100	0–15	0–10	0–10	NP	
Sandy Gravel	50–85	15–50	0–10	0–10	6 Max.	
Sand	0–15	85–100	0–10	0–10	NP	
Gravelly Sand	20–49	45–85	0–10	0–10	6 Max.	
Sandy Loam	0–19	50–80	0–50	0–20	6 Max.	
Sandy Clay Loam	0–19	50–80	0–30	20–30	10 Max.	
Sandy Clay	0–19	55–70	0–15	30–45	11 Min.	
Loam	0–19	30–50	30–50	0–20	10 Max.	
Silt Loam	0–19	0–50	50–100	0–20	10 Max.	
Silty Clay Loam	0–19	0–30	70–100	20–30	11 Min.	
Silty Clay	0–19	0–15	55–70	30–45	11 Min.	
Clay Loam	0–19	20–50	50–80	20–30	11 Min.	
Clay	0–19	0–55	0–55	30–100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only

Site No.	Horizon	Depth in inches	Grav[el] Great[er] than %	[CB]R [surc]harge lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
1	B_{22}	12-39	0	[illegible]	22.7	CH	A-7-6(19)
	B_3	39-4[illegible]	1	[illegible]	20.3	MH-CH	A-7-6(16)
2	A_2	3-11	0	[illegible]	--	CL	A-6(9)
	B_{21}	17-27	0	[illegible]	--	CH	A-7-6(19)
	B_{22}	27-46	0	[illegible]	--	CH	A-7-6(20)
3	A_{12}	4-14	0	[illegible]	--	ML-CL	A-4(8)
	B_{22}	29-44	0	[illegible]	--	CL	A-7-6(11)
	B_{23}	44-63	0	[illegible]	--	CL	A-7-6(12)
4	A_2	7-30	0	[illegible]	14.2	SP-SM	A-3-(0)
	B_{21}	30-78	0	[illegible]	10.3	SP-SM	A-2-4
5	B_2	20-52	0	[illegible]	19.4	ML-CL	A-7-6(11)
	C_1	60-120	1	[illegible]	12.5	CL	A-6(7)
6	A_2	1-8	4	[illegible]	13.3	ML-CL	A-4(7)
	B_2	12-50	2	[illegible]	16.7	CL	A-6(12)
	B_3	50-70	3	[illegible]	13.5	CL	A-7-6(13)
7	A_p	0-7	4	[illegible]	11.6	ML	A-4(5)
	B_{22}	26-44	5	[illegible]	15.5	CL	A-6(6)
	C_1	57-87	3	[illegible]	10.4	SC	A-2-4(0)
8	AC	0-48	0	[illegible]	13.3	ML-CL	A-4(8)
9	C_2	17-74	0	[illegible]	16.1	ML-CL	A-4(8)
10	C_1	9-42	1	[illegible]	—	ML-CL	A-4(8)
11	B_2	14-32	0	[illegible]	18.9	CL	A-6(10)
	B_{32} & C_1	36-46	6	[illegible]	23.0	CH	A-7-6(20)

TABLE II

SOIL TEST DATA FOR OWEN COUNTY

Site No.	Horizon	Depth in inches	Grain Size Distribution: Gravel Greater than #4 %	Fine Gravel #4-#10 %	Coarse Sand #10-#40 %	Fine Sand #40-#200 %	Silt #200 - 0.005 mm %	Clay Less Than 0.005 mm. %	Liquid Limit %	Plastic Index %	Standard Laboratory Compaction (AASHO T99): O.M.C. %	Max. Dry Weight pcf	CBR (Surcharge 35 lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
1	B_{22}	12-39	0	0	0	4	64	32	54	29	22.4	99.8	8	22.7	CH	A-7-6(19)
	B_3	39-48	1	0	1	9	48	41	51	23	20.1	100.2	6	20.3	MH-CH	A-7-6(16)
2	A_2	3-11	0	0	1	9	62	28	32	12	17.7	107.2	-	--	CL	A-6(9)
	B_{21}	17-27	0	1	2	11	42	44	54	34	21.2	101.1	-	--	CH	A-7-6(19)
	B_{22}	27-46	0	1	2	9	37	51	61	36	24.6	99.0	-	--	CH	A-7-6(20)
3	A_{12}	4-14	0	0	1	7	65	27	28	5	16.2	107.4	-	--	ML-CL	A-4(8)
	B_{22}	29-44	0	0	1	5	55	39	41	19	18.7	104.7	-	--	CL	A-7-6(11)
	B_{23}	44-63	0	1	1	11	48	39	41	20	17.2	111.0	-	--	CL	A-7-6(12)
4	A_2	7-30	0	0	30	60	6	4	NP	NP	14.0	103.8	38	14.2	SP-SM	A-3-(0)
	B_{21}	30-78	0	0	31	58	5	6	16	NP	10.9	108.8	21	10.3	SP-SM	A-2-4
5	B_2	20-52	0	0	0	5	65	30	41	17	20.2	102.3	9	19.4	ML-CL	A-7-6(11)
	C_1	60-120	1	2	7	26	44	20	27	12	12.5	118.2	9	12.5	CL	A-6(7)
6	A_2	1-8	4	2	5	19	47	23	26	5	14.0	111.6	21	13.3	ML-CL	A-4(7)
	B_2	12-50	2	1	3	20	35	39	40	19	16.0	111.0	11	16.7	CL	A-6(12)
	B_3	50-70	3	1	3	19	36	38	41	23	16.2	113.5	3	13.5	CL	A-7-6(13)
7	A_p	0-7	4	2	5	29	43	17	20	3	11.4	120.7	28	11.6	ML	A-4(5)
	B_{22}	26-44	5	2	7	28	30	28	34	14	17.0	111.0	13	15.5	CL	A-6(6)
	C_1	57-87	3	3	14	45	17	18	24	8	9.9	123.2	27	10.4	SC	A-2-4(0)
8	AC	0-48	0	0	1	25	56	18	26	6	14.1	112.0	17	13.3	ML-CL	A-4(8)
9	C_2	17-74	0	0	0	8	71	21	31	9	16.1	110.6	19	16.1	ML-CL	A-4(8)
10	C_1	9-42	1	0	1	20	60	18	26	6	14.6	114.4	—	—	ML-CL	A-4(8)
11	B_2	14-32	0	0	2	14	51	33	36	16	19.3	105.0	9	18.9	CL	A-6(10)
	B_{32} & C_1	36-46	6	3	2	14	22	53	77	48	23.3	90.5	2	23.0	CH	A-7-6(20)

Site No.	Hori- zon	Depth in inches	Grav Great than %	harge lbs)	Molded Moisture Content for CBR Test	Unified Classifi- cation	AASHO Classifi- cation
12	B_2	12-32	0		17.8	CL	A-7-6(15)
	C	32-80	0		16.3	CL	A-6 (9)
13	A_{12}	2-10	0		—	CL	A-6(9)
	B_{22}	17-27	0		—	CH	A-7-6(18)
	C_1	27+	0		—	CL	A-7-6(14)
14	A_p	0-9	0		—	ML-CL	A-6(9)
	B_{22}	14-27	0		—	MH-CH	A-7-6(15)
	C_1	27+	0		—	CL	A-7-6(15)
15	B_2	16-56	-		—	—	—
	C_1	90+	0		11.5	SP-SM	A-3(0)
16	B_2	15-37	0		21.7	ML-CL	A-6(10)
	B_{22m}&C_1	37-60	0		19.9	ML-CL	A-7-6(14)
	C_1&C_2	60-90	0		15.4	CL	A-6(10)
17	B_{22}	24-43	0		18.2	ML-CL	A-6(9)
	B_{32}	59-76	0		11.0	SM-SC	A-2-4(0)
18	A_2	3-12	0		—	ML-CL	A-4(8)
	B_{22}	18-28	0		—	CL	A-4(7)
	B_{32}	42-64	0		—	SC	A-6(4)
19	A_2	3-10	0		—	ML-CL	A-4(8)
	B_{22}	25-42	0		—	CL	A-6(10)
	B_{32}	58-91	0		—	SC	A-6(1)
20	B_2	12-36	0		10.3	SM	A-2-4(0)
	C_{11}	44-72	0		13.2	SM	A-2-4(0)

Site No.	Horizon	Depth in inches	Grain Size Distribution: Gravel Greater than #4 %	Fine Gravel #4-#10 %	Coarse Sand #10-#40 %	Fine Sand #40-#200 %	Silt #200 - 0.005 mm %	Clay Less Than 0.005 mm. %	Liquid Limit %	Plastic Index %	Standard Laboratory Compaction (AASHO T99): O.M.C. %	Max. Dry Weight pcf	CBR (Surcharge 35 lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
12	B_2	12-32	0	0	1	5	41	53	46	25	17.8	99.7	1	17.8	CL	A-7-6(15)
	C	32-80	0	1	1	3	40	55	32	12	16.6	108.5	4	16.3	CL	A-6 (9)
13	A_{12}	2-10	0	0	8	21	46	25	35	14	17.0	106.3	-	—	CL	A-6(9)
	B_{22}	17-27	0	0	0	6	30	64	55	28	24.3	97.3	-	—	CH	A-7-6(18)
	C_1	27+	0	1	0	1	30	68	46	23	19.2	109.5	-	—	CL	A-7-6(14)
14	A_p	0-8	0	0	4	9	46	41	37	13	19.8	103.0	-	--	ML-CL	A-6(9)
	B_{22}	14-27	0	0	0	4	33	63	53	26	21.0	100.0	-	—	MH-CH	A-7-6(15)
	C_1	27+	0	0	1	5	33	61	48	24	19.9	105.2	-	—	CL	A-7-6(15)
15	B_2	16-56	-	-	-	-	--	—	NP	NP	13.0	116.1	-	—	—	---
	C_1	90+	0	0	0	94	3	3	NP	NP	11.9	107.0	18	11.5	SP-SM	A-3(0)
16	B_2	15-37	0	0	0	13	55	32	38	15	21.5	103.0	4	21.7	ML-CL	A-6(10)
	B_{22m} & C_1	37-60	0	0	1	5	66	28	48	20	19.9	102.5	11	19.9	ML-CL	A-7-6(14)
	C_1 & C_2	60-90	0	0	0	22	54	24	36	14	15.5	111.5	9	15.4	CL	A-6(10)
17	B_{22}	24-43	0	0	2	5	65	[illegible]	36	13	19.0	102.5	9	18.2	ML-CL	A-6(9)
	B_{32}	59-76	0	0	9	62	14	15	22	6	11.3	122.5	20	11.0	SM-SC	A-2-4(0)
18	A_2	3-12	0	0	2	15	61	22	31	8	17.6	108.4	-	--	ML-CL	A-4(8)
	B_{22}	18-28	0	0	4	26	43	27	26	9	13.1	117.3	-	--	CL	A-4(7)
	B_{32}	42-64	0	0	7	43	21	29	29	14	11.2	120.7	-	—	SC	A-6(4)
19	A_2	3-10	0	0	1	9	64	27	27	4	16.2	106.3	-	--	ML-CL	A-4(8)
	B_{22}	25-42	0	0	1	7	60	32	38	16	17.9	107.7	-	--	CL	A-6(10)
	B_{32}	58-91	0	0	9	53	16	22	23	11	12.5	120.2	-	--	SC	A-6(1)
20	B_2	12-36	0	0	15	57	13	15	18	NP	11.1	121.0	12	10.3	SM	A-2-4(0)
	C_{11}	44-72	0	0	19	68	8	5	18	NP	13.3	111.8	30	13.2	SM	A-2-4(0)

Site No.	Horizon	Depth in inches	Grav Great than %	BR :arge lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
21	A	0-20	0		17.3	ML-CL	A-4(8)
	B_{2m}	20-40	0		19.3	CL	A-7-6(15)
	C_{1g}	42-70+	1		14.8	CL	A-6(8)
22	B_{21}	16-28	0		21.5	ML-CL	A-6(10)
	B_{3m}	43-55	0		18.1	ML-CL	A-6(8)
	C_1	55-56	5		14.8	CL	A-4(6)
23	A_p	0-8	2		--	ML	A-4(8)
	B_{22m}	25-43	0		--	CL	A-6(10)
	C_1	52-79	2		--	CL	A-6(7)
24	A_2	7-14	0		--	ML-CL	A-6(8)
	B_{22m}	24-46	0		--	CL	A-6(11)
	C_1	46-50	6		--	ML-CL	A-4(7)
25	A_1	0-20	0		15.6	CL	A-4(8)
	B_{2m}	23-44	0		17.5	CL	A-7-6(18)
	D_1	50-144	1		15.6	CL	A-6(8)
	D_2	144+	3		10.3	CL	A-4(3)
26	A_2	3-12	0		15.2	ML-CL	A-4(8)
	B_{22m}	26-38	0		20.3	CL	A-7-6(14)
	C_1	52-114	3		10.5	CL	A-6(9)
27	A_p	0-8	0		14.8	ML-CL	A-4(8)
	B_{22m}	25-39	1		15.6	CL	A-6(12)
	C_1	53-135	1		14.6	CL	A-6(11)

Site No.	Horizon	Depth in inches	Grain Size Distribution: Gravel Greater than #4 %	Fine Gravel #4-#10 %	Coarse Sand #10-#40 %	Fine Sand #40-#200 %	Silt #200 - 0.005 mm. %	Clay Less Than .005 mm. %	Liquid Limit %	Plastic Index %	Standard Laboratory Compaction (AASHO T99): O.M.C. %	Max. Dry Weight pcf	CBR (Surcharge 35 lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
21	A	0-20	0	1	2	12	62	[illegible]	29	9	17.1	106.8	21	17.3	ML-CL	A-4(8)
	B_{2m}	20-40	0	0	1	4	61	34	47	23	19.5	100.4	5	19.3	CL	A-7-6(15)
	C_{1g}	40-70+	1	1	4	23	48	[illegible]	32	12	15.1	110.8	8	14.8	CL	A-6(8)
22	B_{21}	16-28	0	0	0	5	62	33	38	15	20.8	102.5	10	21.5	ML-CL	A-6(10)
	B_{3m}	43-55	0	0	2	13	57	23	33	11	18.5	106.5	11	18.1	ML-CL	A-6(8)
	C_1	55-66	5	3	6	19	44	23	24	9	15.1	116.3	2	14.8	CL	A-4(6)
23	A_p	0-8	2	0	3	7	63	25	35	8	19.3	102.9	-	--	ML	A-4(8)
	B_{22m}	25-43	0	0	2	8	55	35	36	15	17.8	108.6	-	—	CL	A-6(10)
	C_1	52-79	2	5	7	27	32	27	30	14	12.9	120.0	-	—	CL	A-6(7)
24	A_2	7-14	0	0	0	10	61	29	36	11	18.2	107.2	-	—	ML-CL	A-6(8)
	B_{22m}	24-46	0	0	0	4	58	28	36	17	20.0	105.9	-	--	CL	A-6(11)
	C_1	46-50	6	4	4	18	48	20	21	6	12.2	118.6	-	—	ML-CL	A-4(7)
25	A_1	0-20	0	1	3	15	65	16	29	9	15.0	109.2	21	15.6	CL	A-4(8)
	B_{2m}	20-42	0	1	3	9	53	34	50	29	17.8	105.2	3	17.5	CL	A-7-6(18)
	D_1	50-144	1	2	5	21	44	27	26	11	16.0	113.7	5	15.6	CL	A-6(8)
	D_2	144+	3	4	12	30	33	18	23	8	10.5	125.2	9	10.3	CL	A-4(3)
26	A_2	3-12	0	0	0	3	60	37	35	10	20.0	98.9	4	15.2	ML-CL	A-4(8)
	B_{22m}	26-38	0	0	0	1	62	37	45	22	19.9	102.0	12	20.3	CL	A-7-6(14)
	C_1	52-114	3	1	4	20	44	[illegible]	31	15	12.4	116.1	4	10.5	CL	A-6(9)
27	A_p	0-8	0	1	2	9	65	23	30	7	15.5	107.5	17	14.8	ML-CL	A-4(8)
	B_{22m}	25-39	1	0	3	11	52	33	40	21	17.0	109.9	10	16.6	CL	A-6(12)
	C_1	53-135	1	2	6	23	34	34	39	20	16.0	112.9	8	14.6	CL	A-6(11)

Site No.	Hori- zon	Depth in inches	Grav Greate than # %	R arge lbs)	Molded Moisture Content for CBR Test	Unified Classifi- cation	AASHO Classifi- cation
28	B_2 & B_{2m}	18-36	0		19.3	ML-CL	A-7-6(11)
	B_{24m}	36-45	0		21.0	CL	A-7-6(12)
	C_1	52-62	1		17.1	CL	A-6(8)
29	A & B_g	0-25	0		22.7	MH	A-7-5(16)
	B_{g2}	25-45	0		18.3	CH	A-7-6(19)
	C	45-100	0		17.3	SM-SC	A-2-4(0)

Site No.	Horizon	Depth in inches	Grain Size Distribution: Gravel Greater than #4 %	Fine Gravel #4–#10 %	Coarse Sand #10–#40 %	Fine Sand #40–#200 %	Silt #200–0.005 mm %	Clay Less Than 0.005 mm. %	Liquid Limit %	Plastic Index %	Standard Laboratory Compaction (AASHO T99): O.M.C. %	Max. Dry Weight pcf	CBR (Surcharge 35 lbs)	Molded Moisture Content for CBR Test	Unified Classification	AASHO Classification
28	B_2 & B_{2m}	18-36	0	0	0	5	67	[illegible]	42	17	19.5	102.1	9	19.3	ML-CL	A-7-6(11)
	B_{24m}	36-45	0	0	1	7	64	[illegible]	41	20	21.4	100.0	6	21.0	CL	A-7-6(12)
	C_1	52-62	1	0	1	10	62	26	30	11	17.0	106.8	9	17.1	CL	A-6(8)
29	A & B_g	0-25	0	0	1	7	32	60	54	22	23.0	93.1	3	22.7	MH	A-7-5(16)
	B_{g2}	25-45	0	0	0	21	28	51	53	31	18.0	101.2	2	18.3	CH	A-7-6(19)
	C	45-100	0	0	3	69	13	15	23	5	16.6	110.1	6	17.3	SM-SC	A-2-4(0)

JHRP

JHRP 66/10
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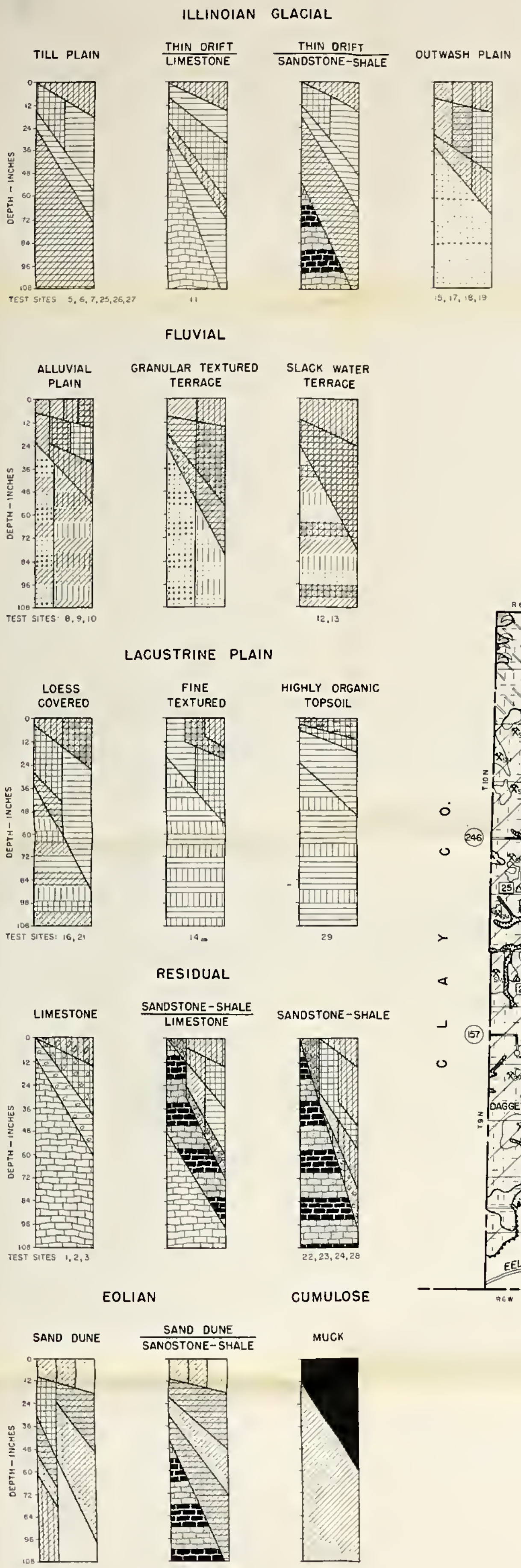
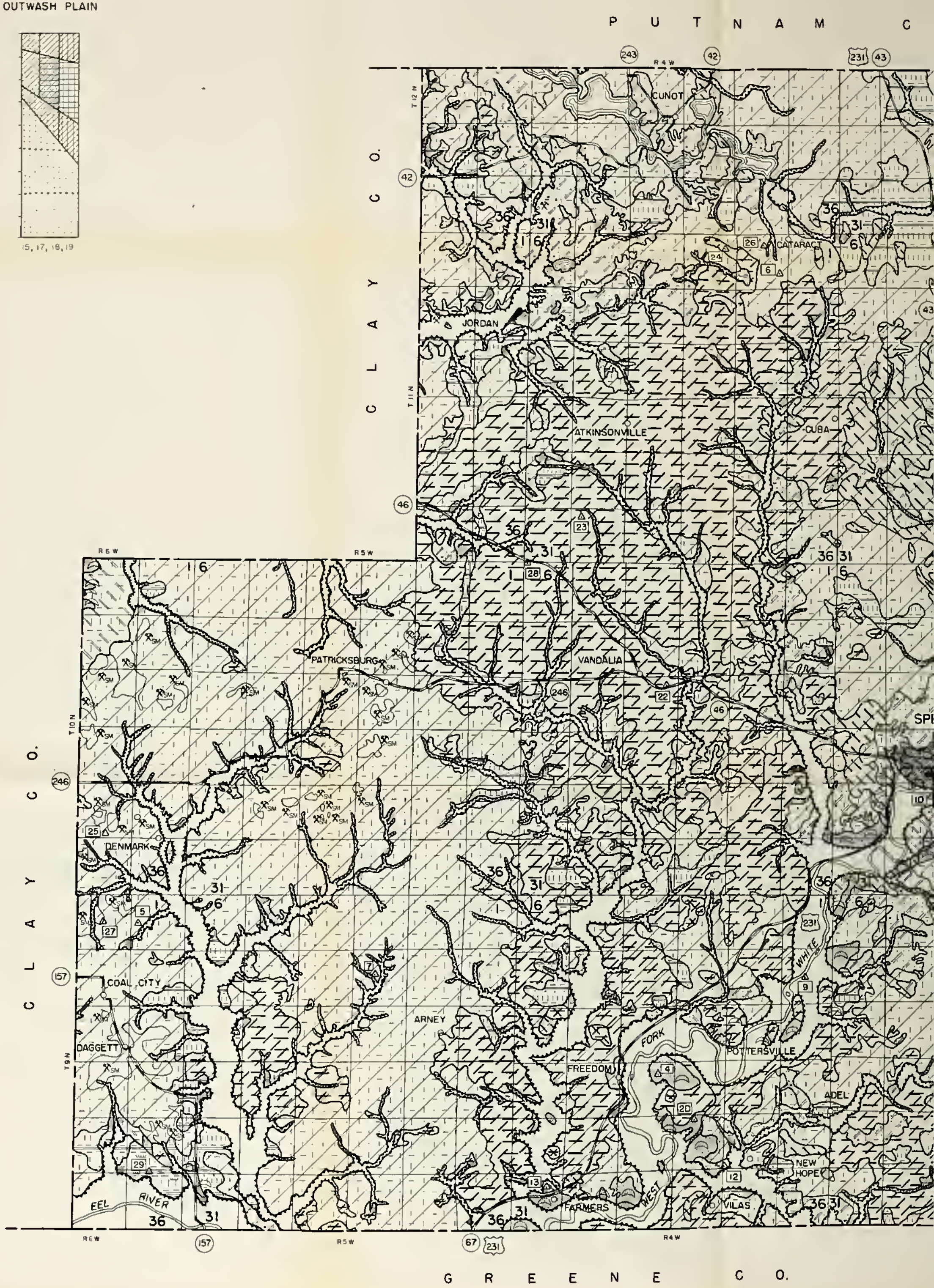
GENERAL SOIL PROFILES





ENGINEERING SOILS MAP

OWEN COUNTY

INDIANA

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AND
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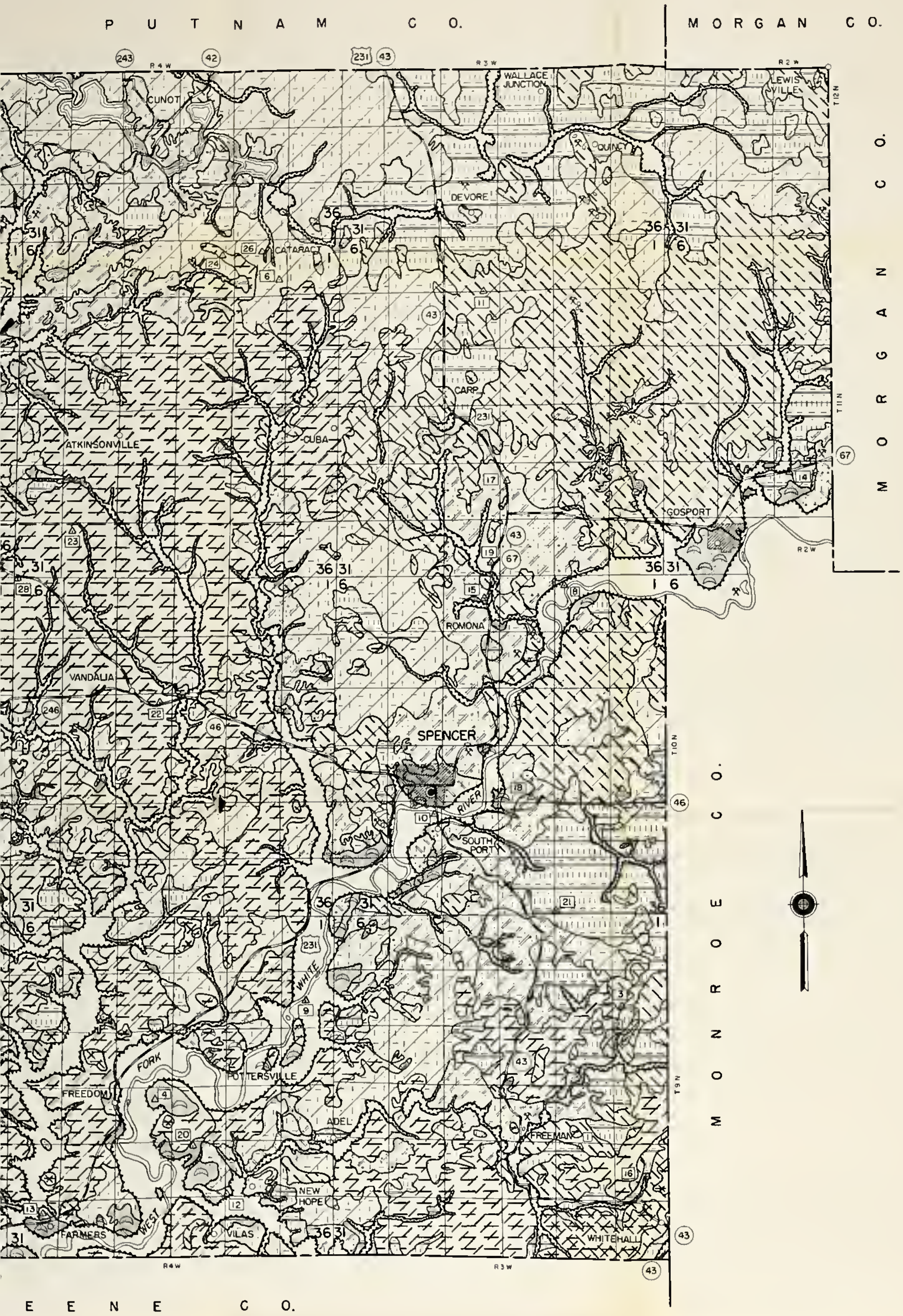
1966

SCALE OF MILES

*PREPARED UNDER THE SUPERVISION OF: P. T. YEH



ENGINEERING SOILS MAP

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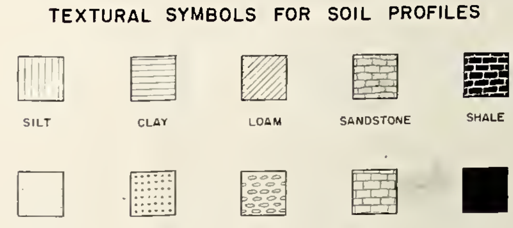
1966

SCALE OF MILES

POLYCONIC PROJECTION

TEXTURAL SYMBOLS FOR SOIL PROFILES



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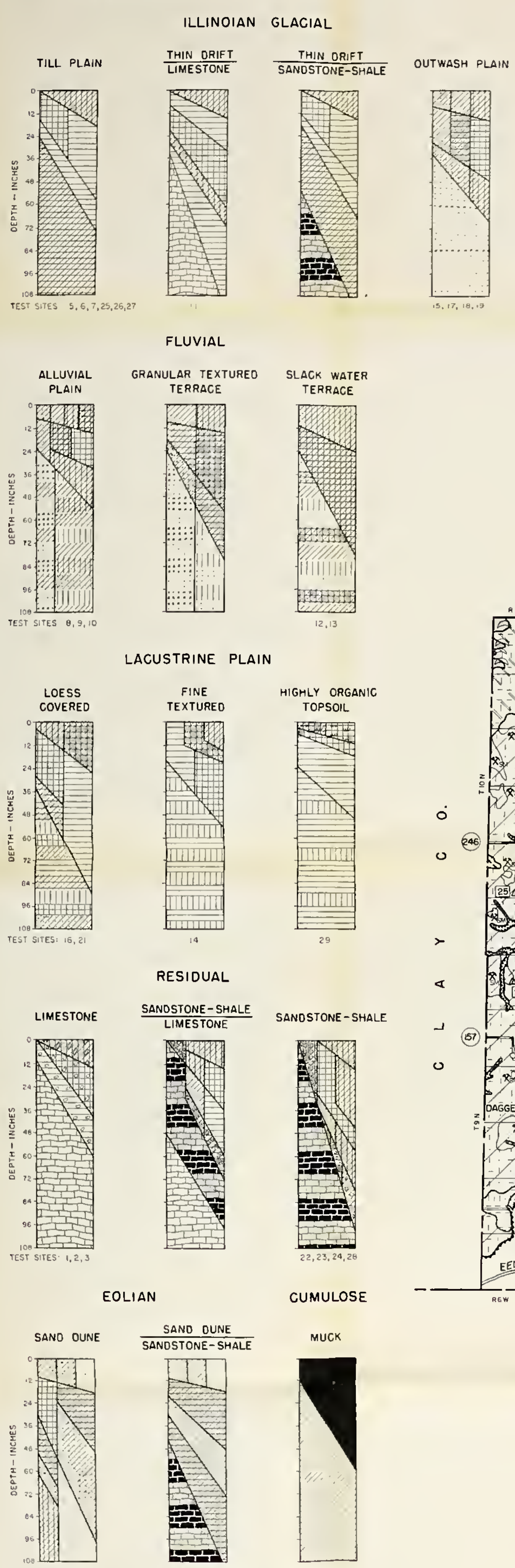
GENERAL SOIL PROFILES



ENGINEERING SOILS MAP

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1966

SCALE OF MILES
1 3/4 1/2 1/4 0 1 2 3 4

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LEGEND

PARENT MATERIALS (GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- LIMESTONE
- INTERBEDDED SANDSTONE AND SHALE
- TILL PLAIN, ILLINOIAN
- THIN ILLINOIAN DRIFT OVER LIMESTONE
- THIN ILLINOIAN DRIFT OVER INTERBEDDED SANDSTONE - SHALE
- INTERBEDDED SANDSTONE - SHALE OVER LIMESTONE
- SAND DUNE
- INCIPIENT SAND DUNE OVER INTERBEDDED SANDSTONE - SHALE
- ALLUVIAL PLAIN
- OUTWASH PLAIN
- LACUSTRINE PLAIN
- TERRACE
- PEAT AND MUCK

MISCELLANEOUS

- STRIP MINE
- STONE QUARRY
- GRAVEL PIT
- LAKE AND POND
- HIGHLY ORGANIC TOP SOIL
- SOIL SAMPLING SITE

TEXTURAL SYMBOLS (SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

SILT CLAY LOAM SANDSTONE SHALE

SAND GRAVEL STONY LIMESTONE MUCK

ENGINEERING SOILS MAP

OWEN COUNTY

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1 3/4 1/2 1/4 0 1 2 3 4

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